

Misuse of Radioactive Material: First Responder Considerations

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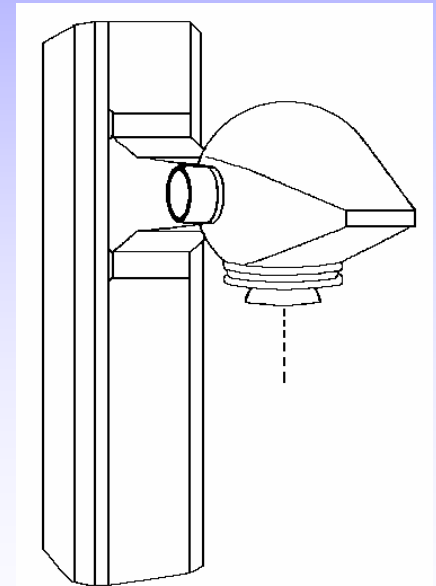
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First Responder Considerations



A Case Study: Goiania, Brazil 1987

- When a hospital changed locations, a radiation therapy unit was temporarily left behind.
- Scrap metal hunters found the unit and dismantled it for scrap metal (~ Sept 18th).
- The 1.4 kiloCi (1,400 Ci) Cs-137 source containment was breached during the process.
- Pieces of source distributed to family and friends.
- Everyone was impressed by “the glowing blue stones.” Children & adults played with them.
- Serious radiological accident recognized on Sept 29th when Acute Radiation Syndrome symptoms were recognized by hospital staff.



Initial Response

112,000 people (10 % of Goiania's population) were surveyed at an Olympic Stadium.

- **250 were identified as contaminated**
- **50 contaminated people were isolated in a camping area inside the Olympic Stadium for more detailed screening**
- **20 people were hospitalized or transferred to special housing with medical and nursing assistance**
- **8 patients transferred to the Navy Hospital in Rio de Janeiro**
- **Residential contamination survey was initiated**



Early Consequences

- Widespread contamination of downtown Goiania
- 85 residences found to have significant contamination (41 of these were evacuated and a few were completely or partially demolished)
- People cross-contaminated houses 100 miles away
- Hot Spots at 3 scrap metal yards and one house



Radiation Injuries and Uptakes

- 4 fatalities (2 men, 1 woman and 1 child)
- 28 patients had radiation induced skin injuries (they held/played with the source for extended periods)
- 50 people had internal deposition (ingestion)

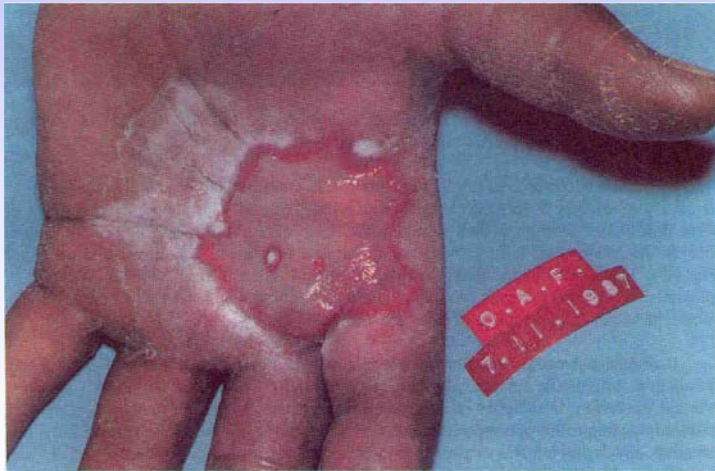
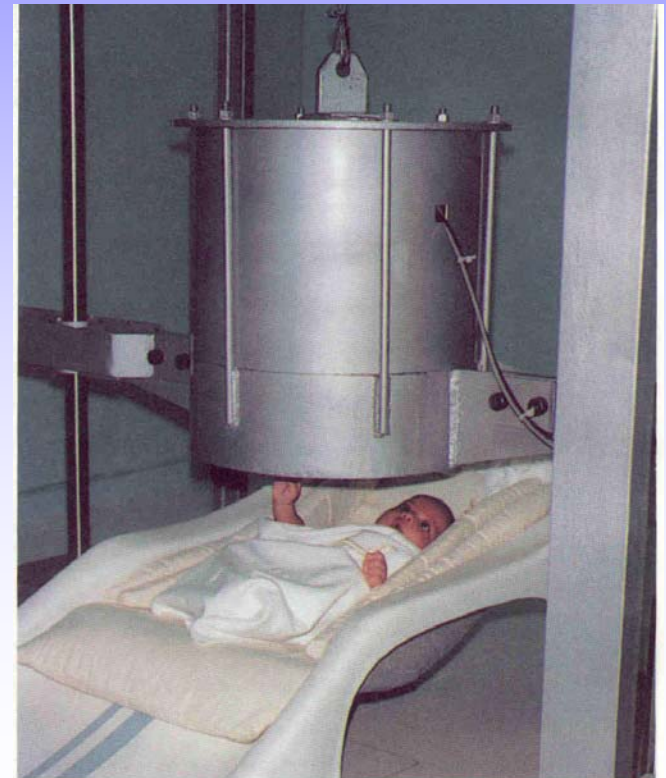


FIG. 9.3. 3–30 days after exposure. The skin was excised. A raw reddish surface is covered with a delicate layer of fibrinous exudate. Note the centripetal character of the healing process and the attempt of re-epithelialization.



Conclusions

- Long and expensive clean-up effort.
- Profound **psychological** effects such as fear and depression on large populations
- Isolation and boycott of goods by neighbors

IAEA-TECDOC-1009

*Dosimetric and
medical aspects of the
radiological accident in
Goiânia in 1987*



INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA

June 1998

Response to a Radiological Incident

~ Contamination ~

- Monitor and isolate contaminated area
- Evacuate and “gross decon” victims (removal of outer clothing is an effective gross decontamination method)
- Avoid breathing in radioactive material
 - Shelter in place (close windows, turn off heating and A/C)
 - Evacuate, when safe to do so
 - Wear respiratory protection
- Radioactive material will not be uniformly distributed. Radiation “Hot Spots” near the source of the event will be a hazard.

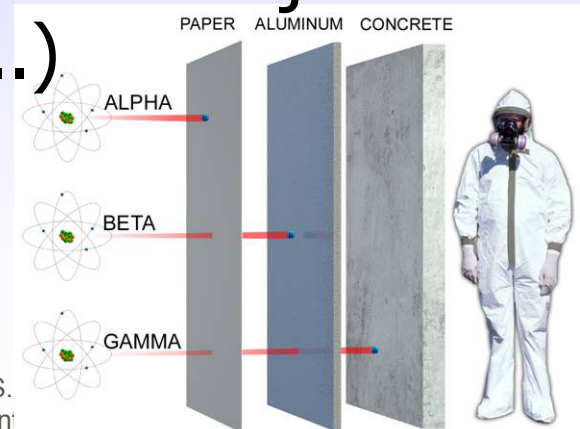


Response to a Radiological Incident

~ Radiation ~



- Time: Limit the time spent in an areas of high radiation
- Distance: Exposure decreases dramatically as you increase your distance from the source.
- Shielding: Radiation is blocked by mass. When practical, operate behind objects (fire trucks, buildings, etc..)



Radiological Considerations for Public Protective Actions

- The EPA has developed Protective Action Guides (PAG) that help responders determine when evacuation is necessary:
 - Shelter & Evacuation PAGs are based on 1 & 5 rem exposures to the public.
 - Emergency phase PAGs are based on a 4 day exposure to “re-suspended” material and is dependent on weather.
 - Developed for acute exposures (such as at a power plant accident), these guidelines are **conservative** for chronic internal exposures.

Example: Brazil's 1.37 kCi (1,370 Ci) Cs-137 Source Made Into a "Dirty Bomb"

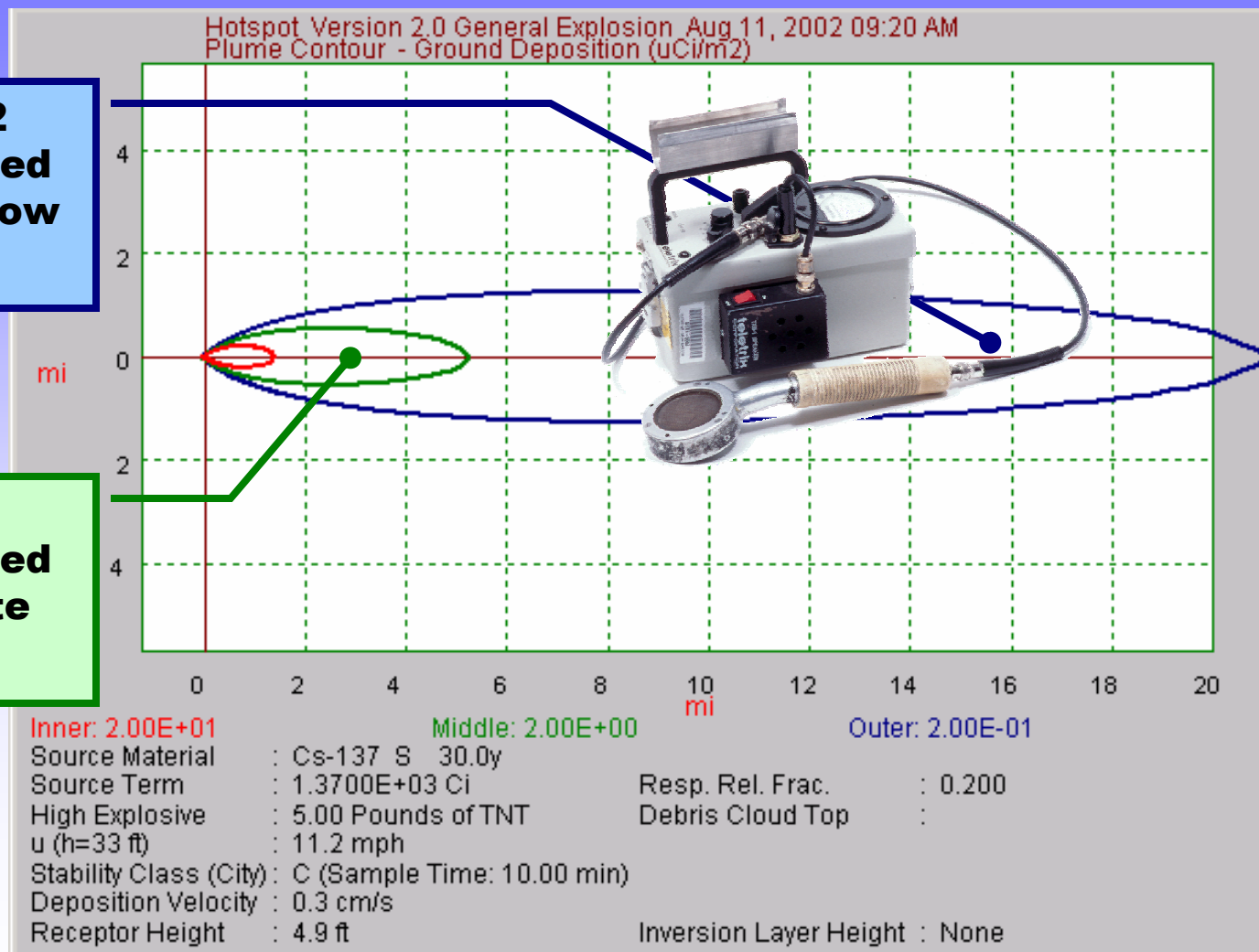
- Despite the accident in Brazil, sources of this strength are very difficult to obtain.
- This model assumes "worse case" in that:
 - The source was 100% aerosolized
 - Lots of explosive (~ 10 sticks of dynamite)
 - Presumes exposed populations "stood outside" during the exposure period.
 - Effects dependent on weather



Detectable Ground Contamination Can be Found Miles Downwind

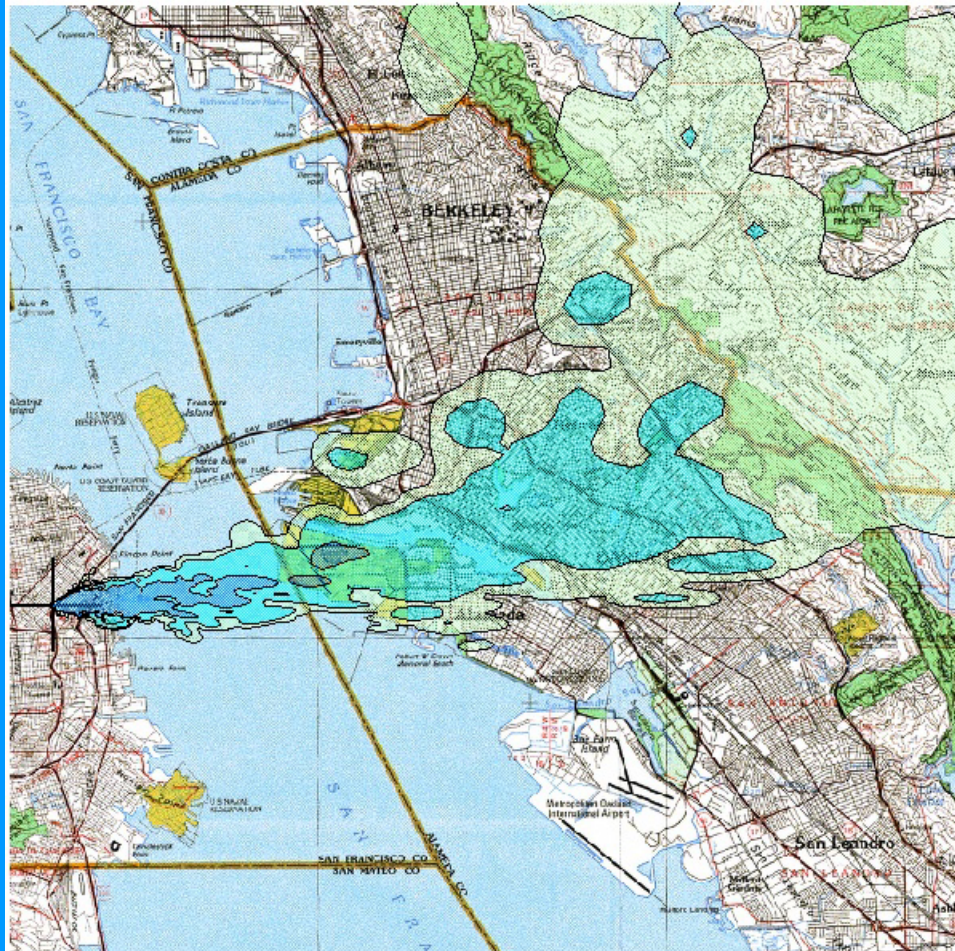
**$\geq 0.2 \text{ uCi/m}^2$
Can be detected
with thin window
G-M meter**

**$\geq 2 \text{ uCi/m}^2$
Can be detected
with dose rate
meter**



San Francisco Example: Ground Contamination Can be Detected East of Berkeley Hills

HYPOTHETICAL



Release: 1.3 KCi CS-137 RDD
with 5 lbs HE
Deposited Contamination

Color	Level (uCi/m ²)	Area (km ²)	Description
Blue	20	5.4	Take measures to prevent cross contamination.
Cyan	2	59.04	Detectable with "hot dog" GM
Light Green	0.2	409.34	Detectable with "Pancake" GM

Release location: San Francisco Police
Department, 850 Bryant
37° 46' 31" N 122° 24' 15" W

100% Aerosolized release fraction

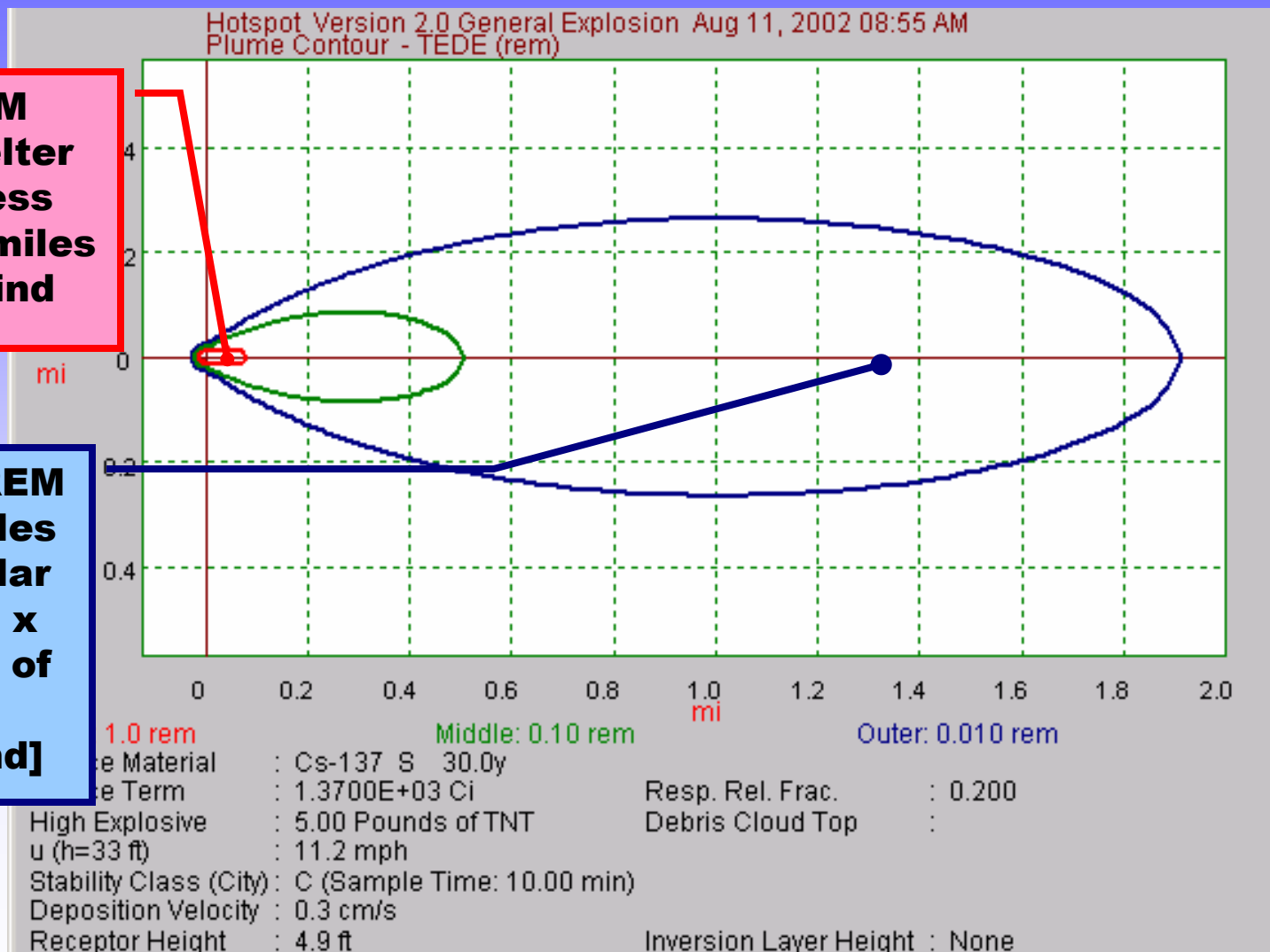
Strong afternoon west winds 18-25 mph.

Map size: 25 x 25 km

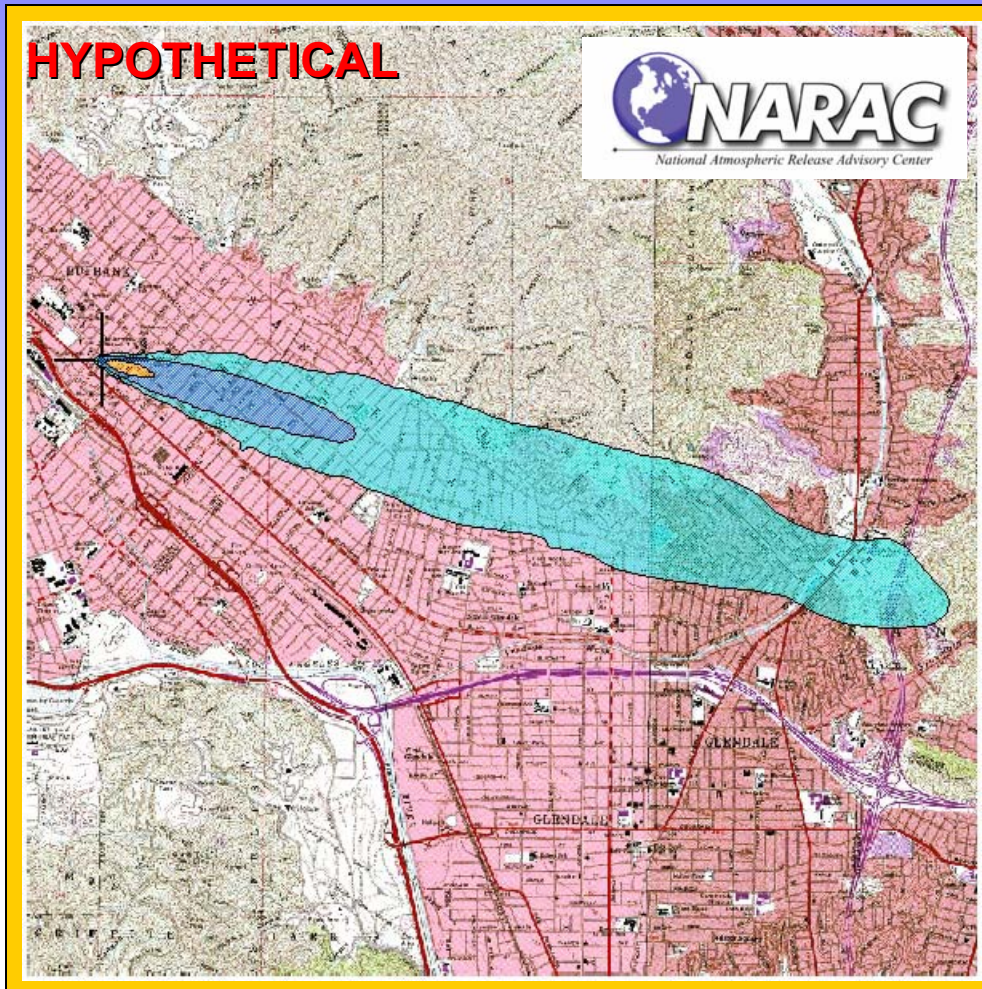
Despite Widespread Contamination, There Are Relatively Small Exposures

**≥1 REM
EPA Shelter
Area Less
than 0.1 miles
downwind**

**0.01 – 0.1 REM
out to 2 miles
[Dose similar
to a chest x
ray or 10% of
natural
background]**



Los Angeles Example: EPA PAG Would Recommend Shelter/Evacuation of a Few Residential Blocks



Release: 1.3 KCi CS-137 RDD
with 5 lbs HE

4-Day Dose (Internal + External)
Evacuation/Relocation PAG

Color	Level (Rem)	Area (km ²)	Description
Yellow	1	0.026	Consider evacuation. Shelter in place if no evacuation.
Blue	0.1	.42	
Cyan	0.01	3.84	

Release location: Burbank Police Department
34 10' 60"N, 118 18' 31"W

100% Aerosolized release fraction

Normal summertime west-northwest winds,
10-12 mph.

Map size: 6 x 6 km

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Conclusion:

First Responder Considerations

- Acute health effects from radiation dose are unlikely without prolonged, high-concentration exposure.
- Contamination readily detectable at long distances.
- Medical emergencies take precedent over radiological monitoring.
- Wear respiratory protection, isolate area.
- Use decontamination techniques (removing outer clothing most effective)
- **Call for assistance**

References

Transportation Emergency Preparedness Program (TEPP)

<http://www.em.doe.gov/otem/program.html>

Predictive Modeling Provided By

HotSpot Health Physics Code v2.0, Steve Homann LLNL

National Release Advisory Center, LLNL (<http://narac.llnl.gov/>)

Gioania References Provided By

IAEA-TECDOC-1009, "Dosimetric and medical aspects of the radiological accident in Goiania in 1987," June 1998, International Atomic Energy Agency.

Radiation Emergency Assistance Services (SAER) from the Institute for Radiation Protection & Dosimetry (IRD), BRAZIL, Raul dos Santos.

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